MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2022/2023

ERE1036 – BASIC ELECTRONICS

(All Sections / Groups)

4 JULY 2023
9.00 a.m. - 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 5 pages including the cover page. There are 4 questions in this final exam.

2. Attempt **ALL** questions. The distribution of marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) Describe in atomic level how the extrinsic silicon semiconductor N-type and P-type are formed, respectively. Explain how they provide free carriers (electrons and holes) to become more conductive compared to its intrinsic semiconductor. Sketch the atomic structure and the energy diagram for each extrinsic semiconductors on your explanation.

[14 marks]

(b) An extrinsic silicon semiconductor is doped with Phosphorus impurities $N_D = 8 \times 10^{17}$ cm^{-3} at temperature T = 300 K. Given the intrinsic carrier concentration, $n_i = 2.5 \times 10^{10}$ cm^{-3}, the silicon electron and hole mobilities are μ_n = 3800 cm^2/V-s and μ_p = 1800 cm^2/V-s, respectively at this temperature. By making an appropriate assumption, determine the majority and minority carriers of this extrinsic semiconductor and the conductivity and resistivity of this extrinsic sample. [6 marks]

(c) A circuit with a diode is shown in Figure Q1. Use the *piecewise linear diode model* to represent the silicon diode D1 in the circuit. Given resistor R = 3 kΩ, V_γ = 0.7 V, and R_f = 20 Ω.

(i) Determine the diode current, I_D. [3 marks]

(ii) If V_s is increased to 15 V, determine the new R value so that I_D is the same as in Part (i).

[2 marks]

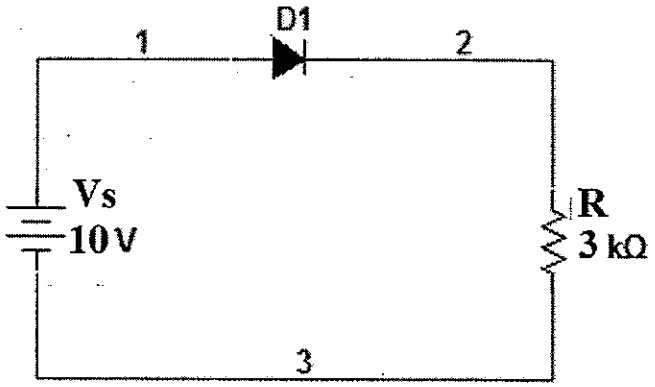

Figure Q1

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Question 2

(a) A rectifier circuit with a step-down transformer (turn ratio n = 10:1) is shown in Figure Q2. Its primary supply source, *Vp* is 230V with 60 Hz. The output resistance R_L is 3kΩ and the voltage drop across forward-biased diode D is 0.7 V. Determine the following values:

(i) The RMS value of the secondary voltage $V_{S(rms)}$ and the peak input voltage, $V_{S(m)}$. [2+2 marks]

(ii) The peak output voltage, $V_{o(m)}$ and the average output voltage, $V_{o(av)}$. [2+2 marks]

(iii) The average load current, $I_{o(av)}$. [2 marks]

(iv) The RMS output voltage, $V_{o(rms)}$ and the RMS load current, $I_{o(rms)}$. [2+2 marks]

(v) The Ripple Factor, γ of the output voltage. [2+2 marks]

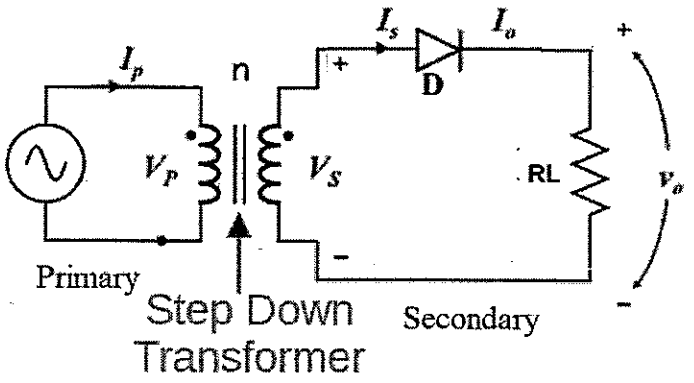

Figure Q2

(b) Given that Silicon diodes have a cut-in voltage of 0.7V and Germanium diodes 0.3V. Design a limiter circuit using Silicon diode(s), Germanium diode(s) and 100Ω resistor to provide an output signal which is clipped as per followings voltages.

(i) Clipped at -1.3V and below. [3.5 marks]

(ii) Clipped at +1.4V and above. [3.5 marks]

Continued...

Question 3

(a) Describe the active mode operation of a NPN type of bipolar transistor (BJT) in terms of its majority and minority carrier flow and current flow. Sketch a suitable diagram with a label to elaborate the process.

[6+4 marks]

(b) Figure Q3 shows an emitter-stabilised bias BJT circuit, with $R_B = 500\ \text{k}\Omega$, $R_C = 2\ \text{k}\Omega$, and $R_E = 420\ \Omega$. Given that the DC amplification factor, $\beta = 200$, $V_{CC} = 10$ V, and $V_{BE} = 0.7$ V. Determine the following:

(i) Base current I_B and emitter currents I_E. [7 marks]

(ii) The Q-point, I_{CQ} and V_{CEQ}. [5 marks]

(iii) DC load line, $I_{C(sat)}$ and $V_{CE(cutoff)}$. [3 marks]

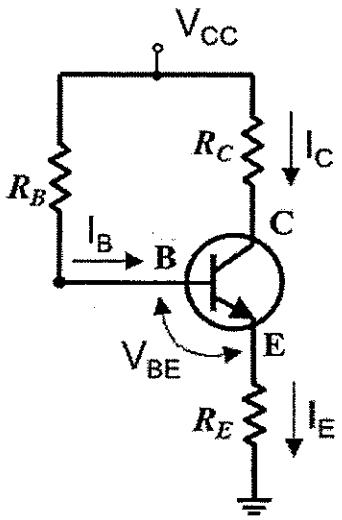

Figure Q3

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Question 4

A typical common-emitter bipolar junction transistor (BJT) circuit is shown in Figure Q4 with all the component values. Given the operating temperature is 27°C with the thermal voltage $V_T = 26$ mV and Early voltage, $V_A = 80$V.

(i) Draw the small signal equivalent circuit of the amplifier using these three different transistor models, namely: *h-parameter* model, hybrid-π model and r_e transistor model. Clearly label the AC elements of i_b, i_c, v_{be} and v_o in each of the circuit diagrams.

[4+4+4 marks]

(ii) Use the approximation method to determine the base voltage (V_B), emitter current (I_E) and base-emitter resistance (β_{re}).

[5 marks]

(iii) Determine the effective input impedance Z_{in}'.

[4 marks]

(iv) Determine the effective output impedance Z_{out}' if a load resistor R_L=1kΩ is connected to *Vo*.

[4 marks]

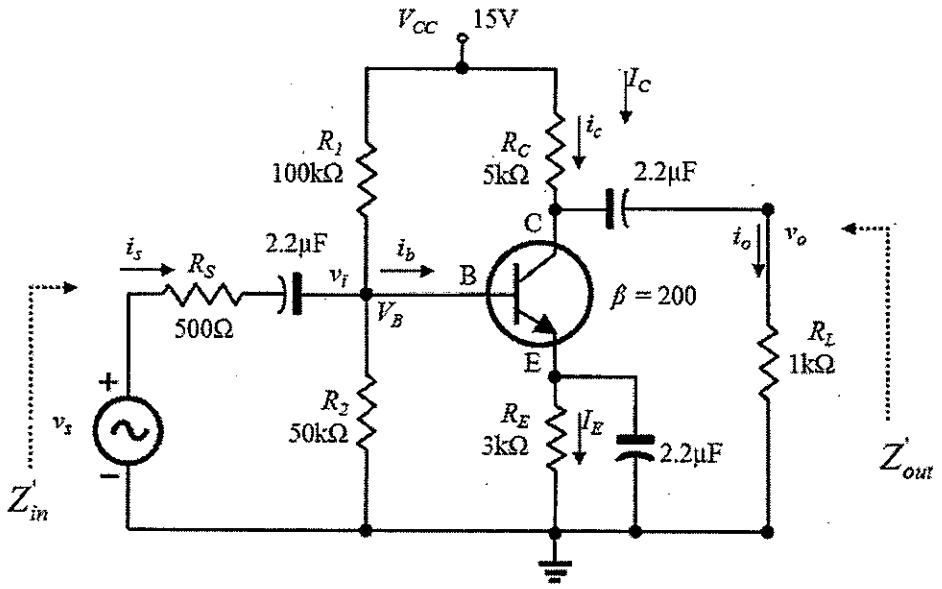

Figure Q4

End of Paper